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INDIA'S PV MANUFACTURING AND ITS STRATEGIC INFLECTION POINTS

Reflecting on the Strategy to Solar Autonomy

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SESSION STRUCTURE (15 MIN)

A concise path from data → strategy → next actions

1) Global market reality

Overcapacity, price compression, and technology shift

2) Where India is today

Value-chain capacity, import exposure, and near-term constraints

3) Autonomy pathways

What “self-reliance” can mean (and what it costs)

4) What must happen next

Policy + execution priorities for

India is scaling fast but autonomy hinges on the “upstream” of the value chain

~144 GW/yr module assembly is already in place (Dec-2025)

Downstream scale is real; upstream remains the binding constraint.

Upstream gap: ~0 GW polysilicon and ~2 GW wafer/ingot today

Import exposure persists for critical inputs, plus BOM (glass, frames).

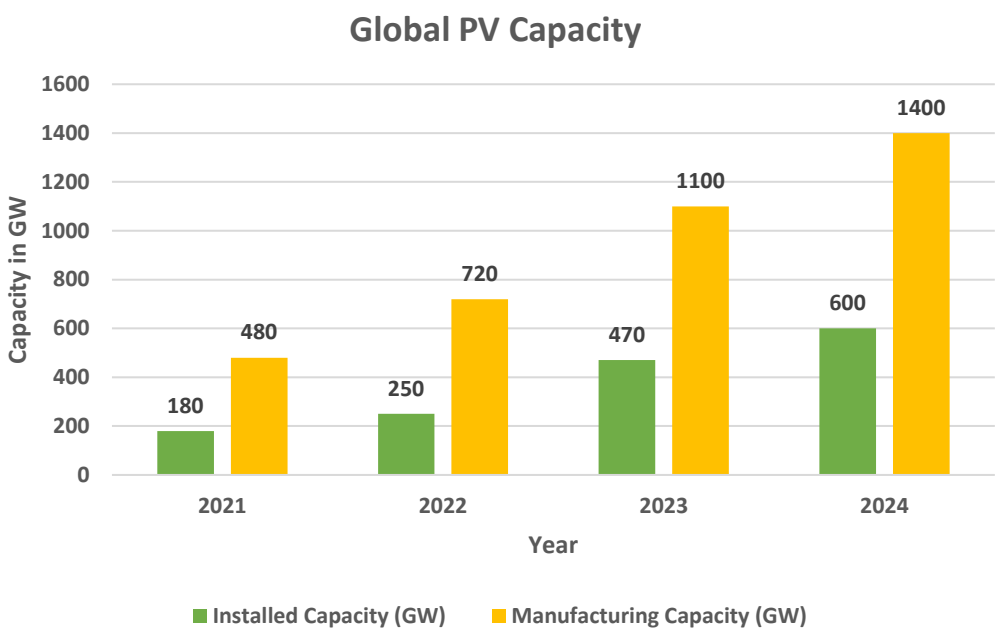
2030 is the decisive window for bankable, high-quality “Made in India”

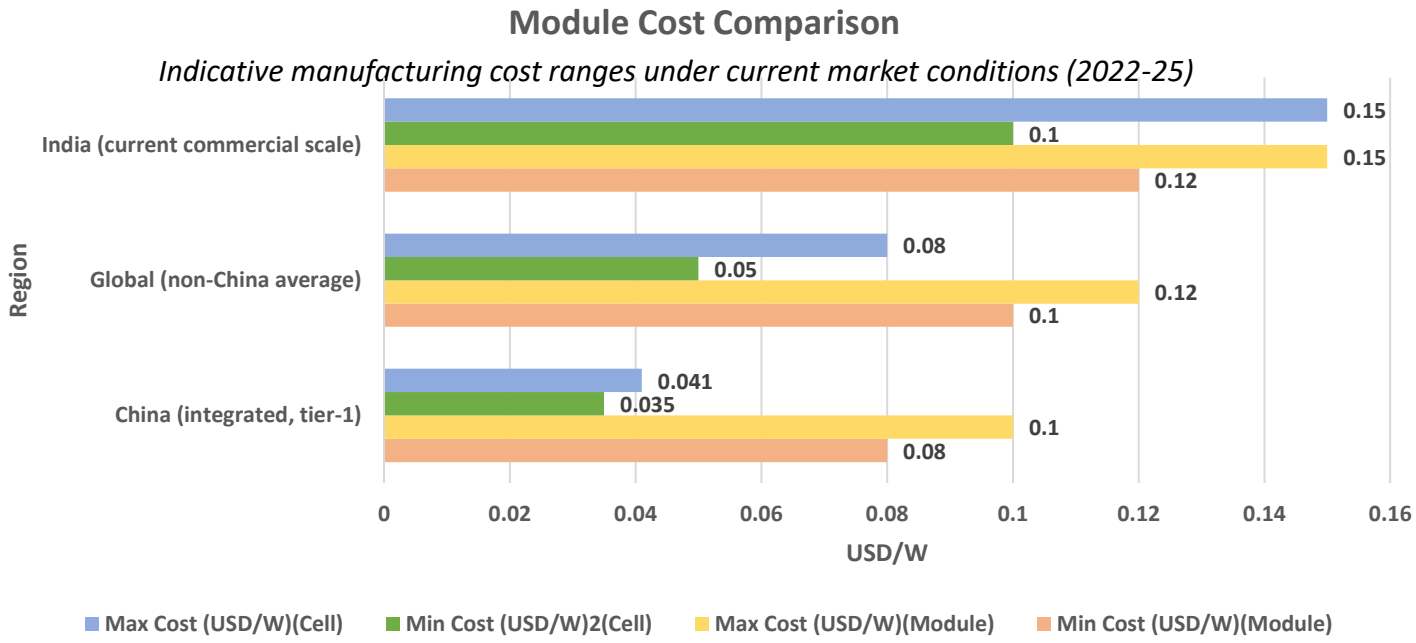
Quality + traceability + cost of capital will separate winners from nameplate capacity.

India has module scale, but autonomy will be decided upstream and in the BOM “middle”

Global PV is oversupplied, so competitiveness is now about cost-of-capital and cash efficiency

In an oversupplied world, utilisation beats nameplate capacity.

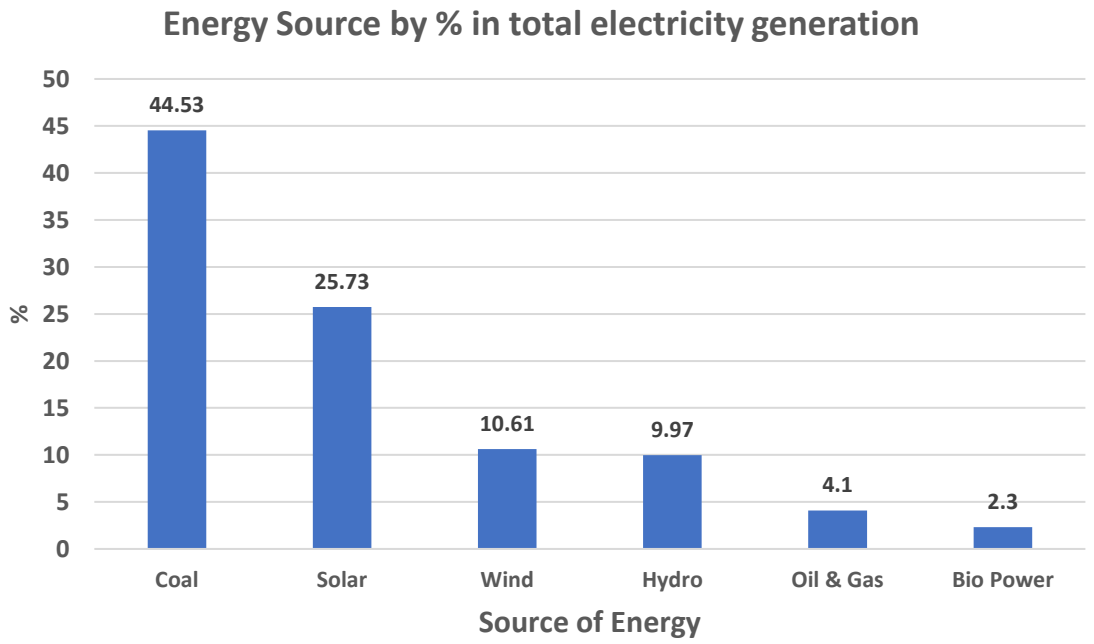


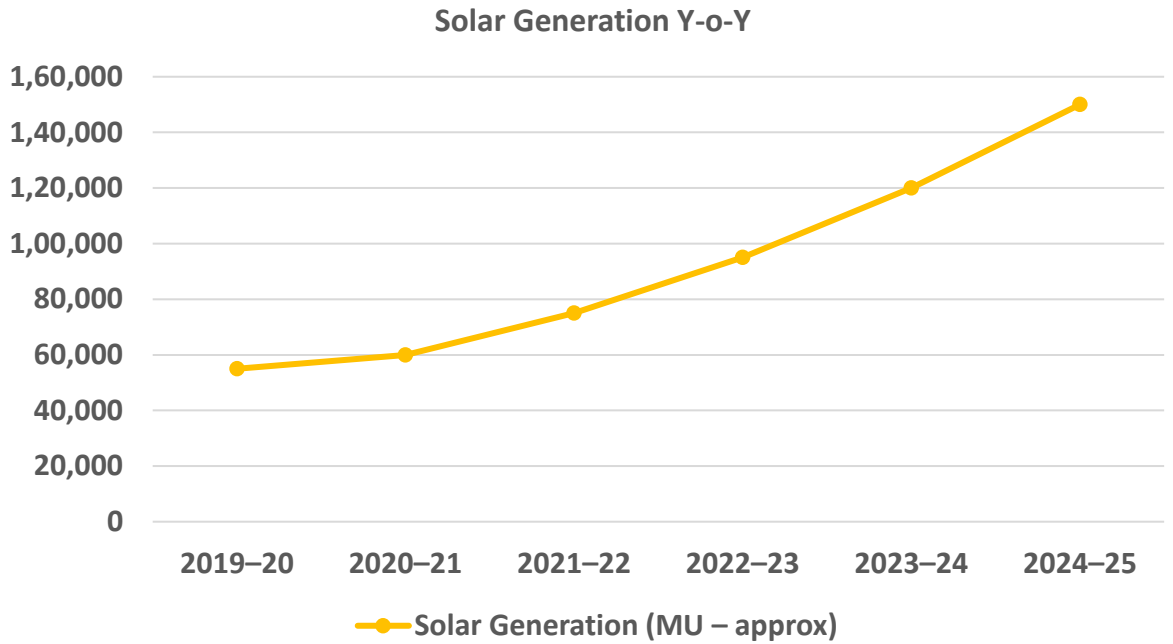


- Global PV manufacturing capacity significantly exceeds annual installations, leading to persistent utilization risk
- Rapid scale-up across polysilicon, wafers, cells, and modules has compressed prices close to marginal cost
- In this environment, cost of capital and working-capital efficiency increasingly shape competitiveness

Source: Authors Compilations from several sources like IEA PVPS, Mercom India, IEEEFA report, PV magazine etc.

Capacity vs Contribution





Solar contributes 26% in India's electricity installed capacity & meets ~10% of Electricity demand

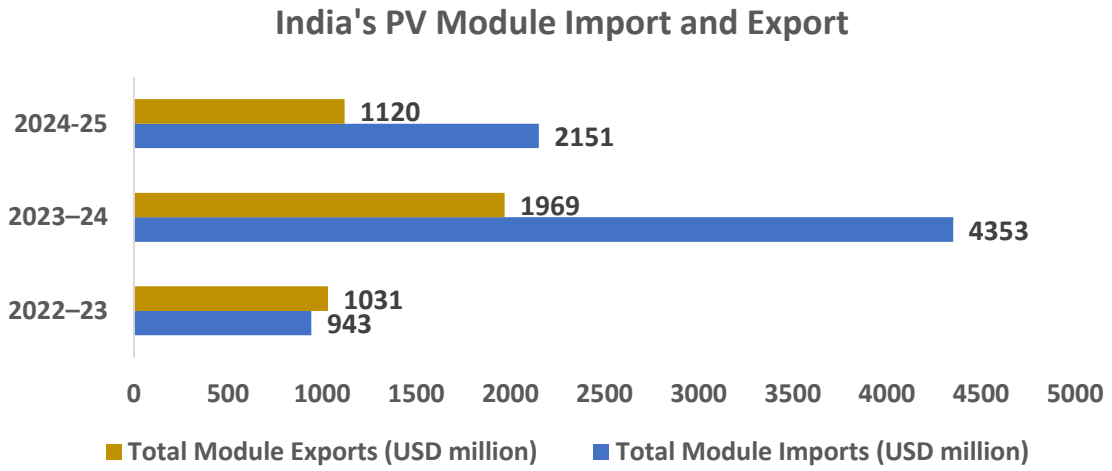
~3× increase in 5 years

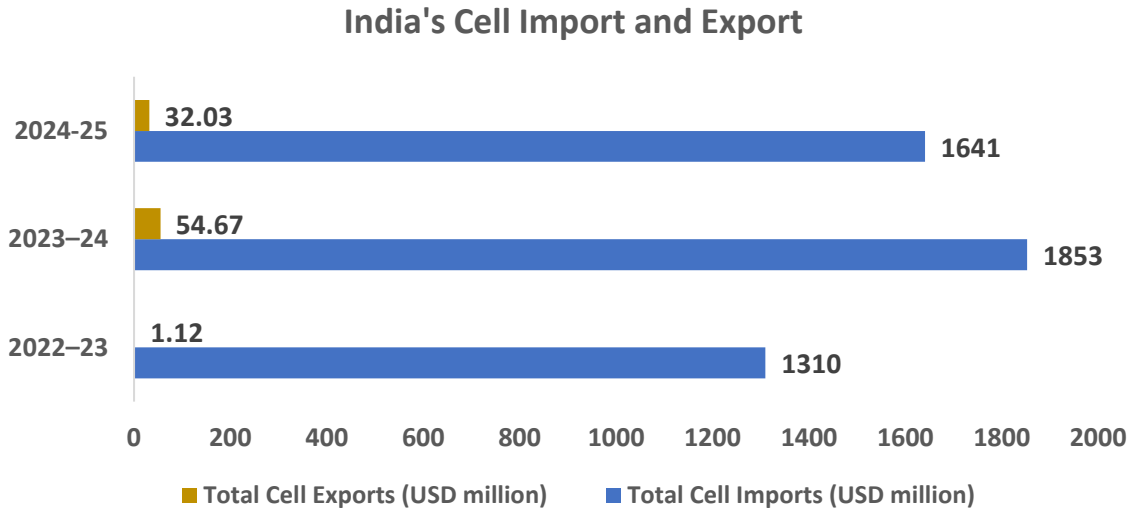
Manufacturing implication: Bridging the gap between solar's capacity share and its system-level contribution requires manufacturing scale, high utilisation, and upstream integration, beyond installation-led growth alone.

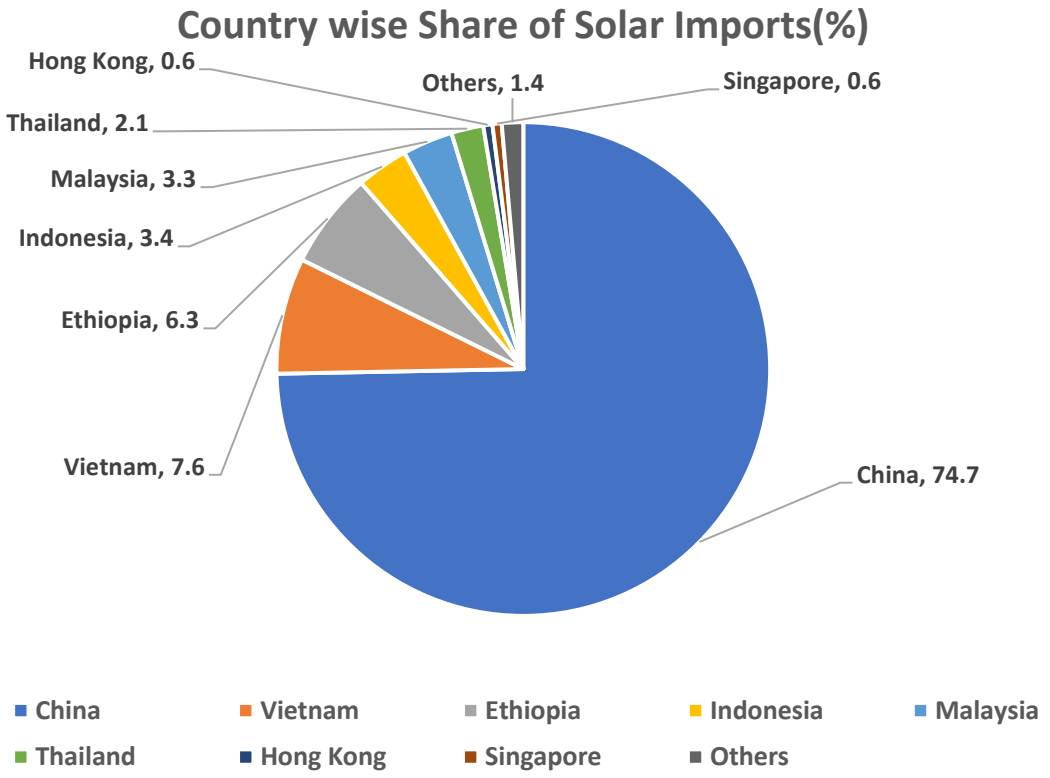
India has installed ~133 GW of solar capacity, translating into annual module demand of ~37 GWac.

Source: ICED, Niti Ayog

India's Solar Manufacturing Remains Import-Dependent







- **Cell imports consistently exceed module imports, highlighting weak upstream capacity**
- **Exports remain marginal across both segments despite PLI support**
- **~75% of solar imports originate from China, indicating concentrated supply risk**

Source: Mercom India; Tradestat

Manufacturing scale is downstream-heavy: upstream remains nascent

2025 Cumulative Manufacturing Capacity (approx.)

Polysilicon

0 GW

No commercial-scale production

Ingot / Wafer

~2 GW

Early backward integration

PV Cell

~30 GW

Consolidated among top players

Module

~144 GW

Large downstream footprint

BOM constraints are emerging:

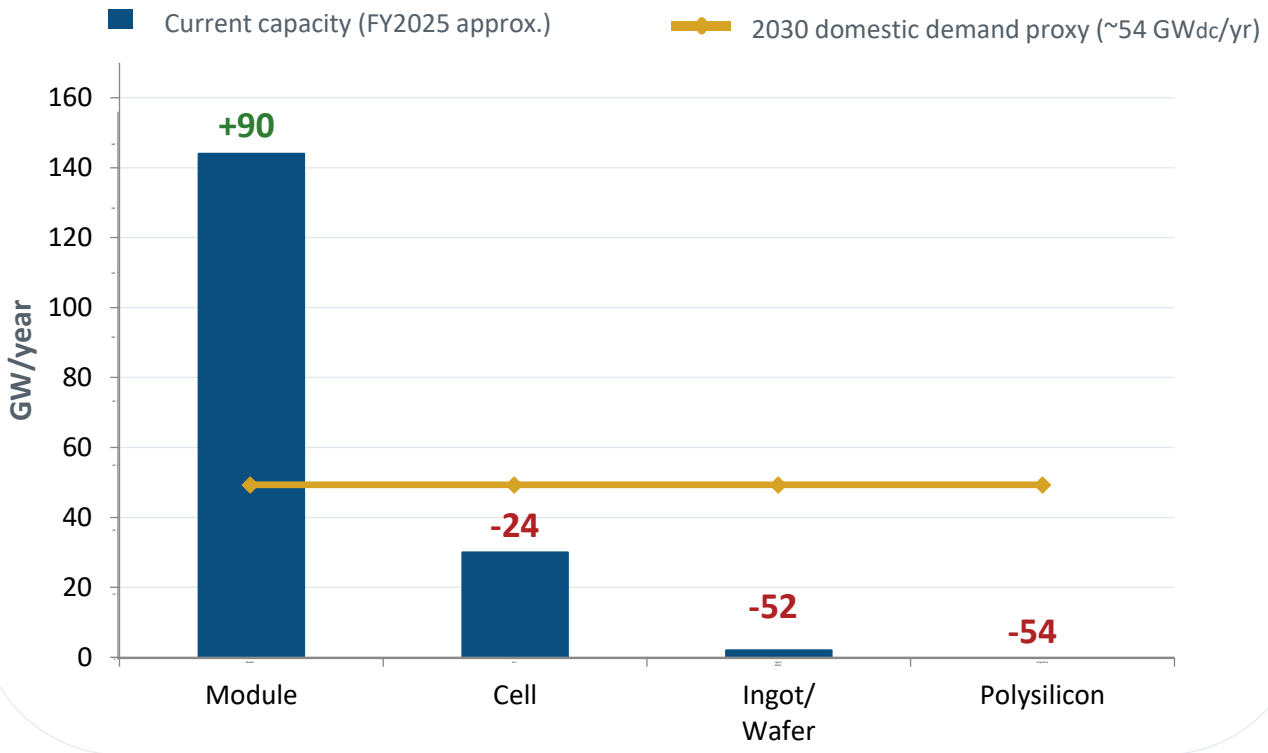
~15 GW/yr solar glass capacity and ~17 GW/yr aluminium frames.

→ Without upstream + BOM scale-up, nameplate module capacity will not translate to secure autonomy.

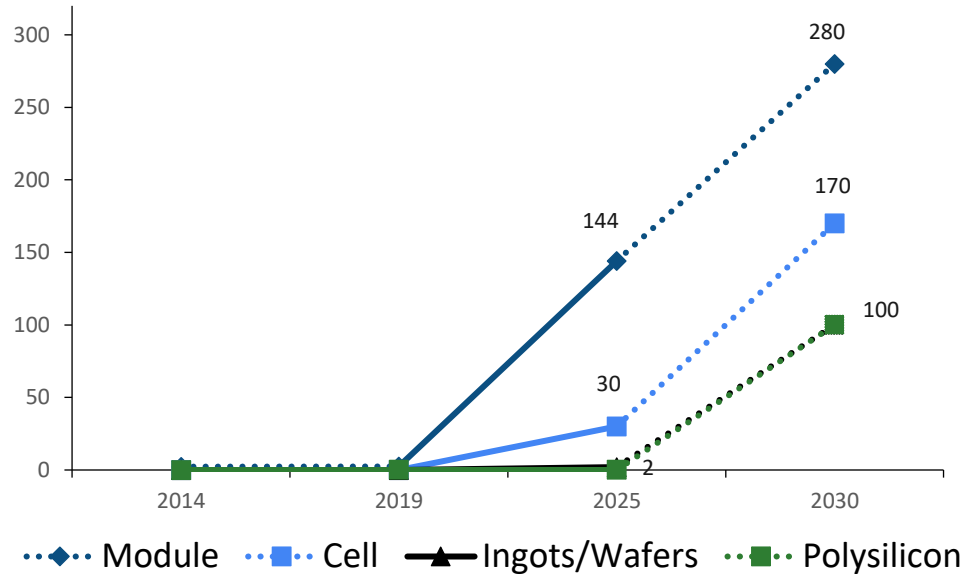
India is building a module surplus, but upstream deficits can ‘import-lock’ the PV value chain by 2030

Left: current capacity vs 2030 domestic requirement proxy. Right: projected scale-up pathway to 2030.

Current supply vs 2030 demand proxy (GWdc/year)



Projected scale-up pathway to 2030 (as of Oct 2025)



Key link: wafer + polysilicon execution is the condition for cell scale-up to translate into domestic value-add.

Implication: module scale is ahead of demand; upstream commissioning pace will determine whether import exposure actually falls.

Policy has reshaped market incentives, next phase must deepen integration

2019

ALMM Order

Approved list requirement for modules

2021–22

BCD on imports

40% modules, 25% cells (from 1 Apr 2022)

2021–24

PLI (Tranche I/II)

48 GW integrated capacity enabled; >₹1 lakh cr investment

Ongoing

DCR & public procurement

Demand anchoring in specific segments

What worked

- Demand assurance & market access
- Tariff + non-tariff barriers shifted sourcing
- PLI reduced payback risk for integrated lines

What must change next

- Backward integration must be matched with raw-material security
- Finance: cost of capital & working-capital terms
- Standards + traceability to protect bankability

Four constraints can cap utilisation even with high nameplate capacity

Upstream materials

Polysilicon (0 GW) and wafers (~2 GW) keep India exposed to commodity and logistics shocks.

BOM supply limits

Solar glass (~15 GW/yr) and frames (~17 GW/yr) can become binding as utilisation rises.

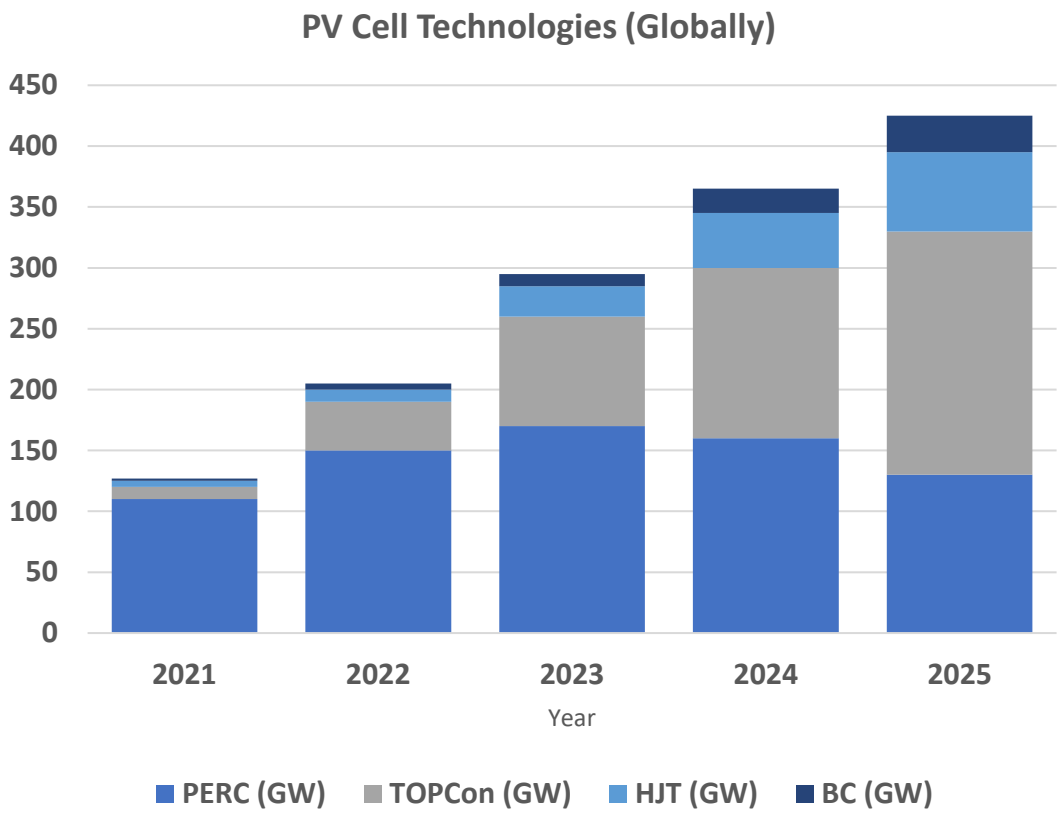
Finance & working capital

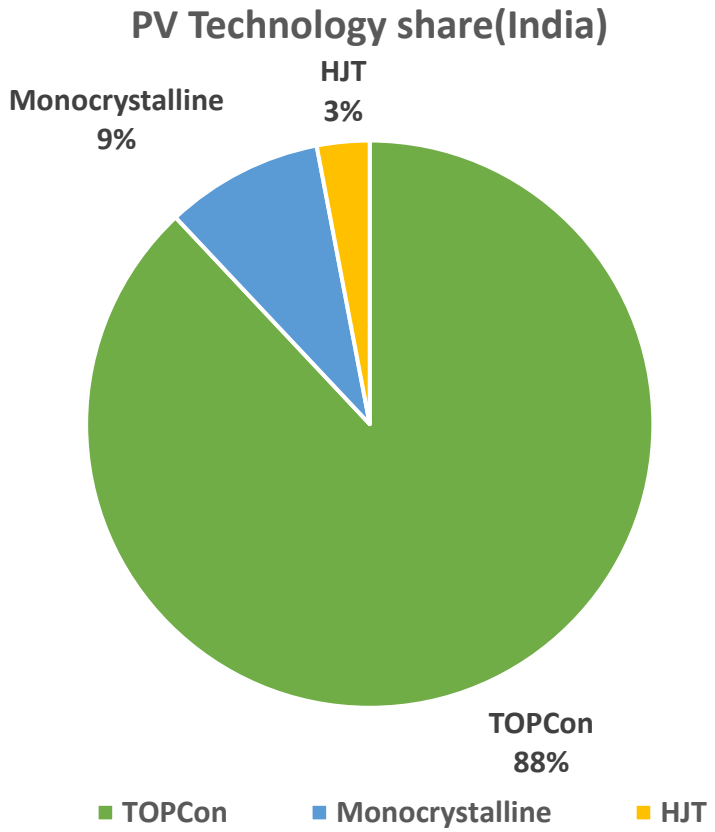
Low-cost debt + WC terms often matter more than capex subsidies for price competitiveness.

Quality & bankability

ALMM plus traceability/ESG expectations are increasingly prerequisites for project finance.

PV Cell Technology Transition: Global vs India





- TOPCon dominates globally and in India, reaching ~44% global share and >90% of India's new module additions (H1 2025).
- PERC continues to lose relevance globally, as manufacturers accelerate the shift toward higher-efficiency cell technologies.
- Technology breadth remains limited, with HJT adoption still nascent and no upstream manufacturing additions observed in India.

Source: Mercom India; Taiyang News

Build domestic equipment capability with a staged roadmap

Short-term (0–24 months) actions that unlock long-term competitiveness

Incentivise PV equipment

Launch targeted incentive for precision PV tools (tabbing, laminators, coating, etc.)

Pilot test-bed line

Commission a ~100 MW demo line at a research institute to validate domestic tools

Import reduction targets

Achieve ≥20% local equipment (by value) in new module lines; ≥10% in new cell lines

Skill pipeline

Launch "Solar Equipment Talent Initiative" for design, automation and service engineers

Domestic equipment integration

Target 50% local equipment (by value) in new module plants; 25% in new cell plants

→

Integrated pilot (poly→module)

Commission an integrated pilot line with indigenous equipment across at least one segment

→

Approved PV equipment vendors

Create certification list for domestic tools; define performance standards

→

R&D breakthroughs

Enable lab-to-fab transfer (e.g., TOPCon process step, kerfless wafer pilot)

Bankability is expanding beyond price: traceability, carbon and end-of-life matter

Traceability

- Supplier disclosure
- Material provenance
- Audit-ready documentation

Low-carbon manufacturing

- Energy source for manufacturing
- Embodied emissions reporting
- Customer procurement criteria

Circularity

- Design for recyclability
- E-waste integration
- Recycling supply chains

ESG readiness is becoming a trade enabler, particularly for exports and for finance backed by international investors.

From ‘copy-paste’ assembly to autonomy: disrupt the chain at four leverage points

A practical playbook to shift India from volume-led localisation to technology- and ecosystem-led self-reliance

Ecosystem depth

1) Bankable domestic loading + quality enforcement

Standardise specifications, traceability, and testing; procurement rewards reliability, not just lowest bid.

2) ‘Usable GW’ operating excellence (yield + OEE)

Link incentives to yield and uptime; build metrology + SPC as default; warranty-backed performance disciplines.

3) Upstream choke-point build-out (wafers/poly + inputs)

Synchronise wafer + polysilicon with cell scale-up; qualify chemicals, pastes, glass, spares locally.

4) Platform scale: cell-foundry / cluster strategy

3–5 clusters (15–30 GW each) with shared chemical parks, labs, logistics; upgrade-ready toolsets and planned line refresh.

Technology ambition (incremental → upgrade-ready, n-type/BC capable)

Takeaway: Autonomy is achieved when upstream capability + learning intensity rise faster than downstream capacity expansion.

A compact KPI set for 2030

Track execution, not just announcements

Utilisation

≥70%

for tier-1 lines (sustained)

(Manufacturers / Lenders)

Backward integration

Wafer + poly

bankable roadmaps with energy planning

(Industry + policymakers)

Quality

ALMM+

reliability + traceability readiness

(Buyers / Financiers)

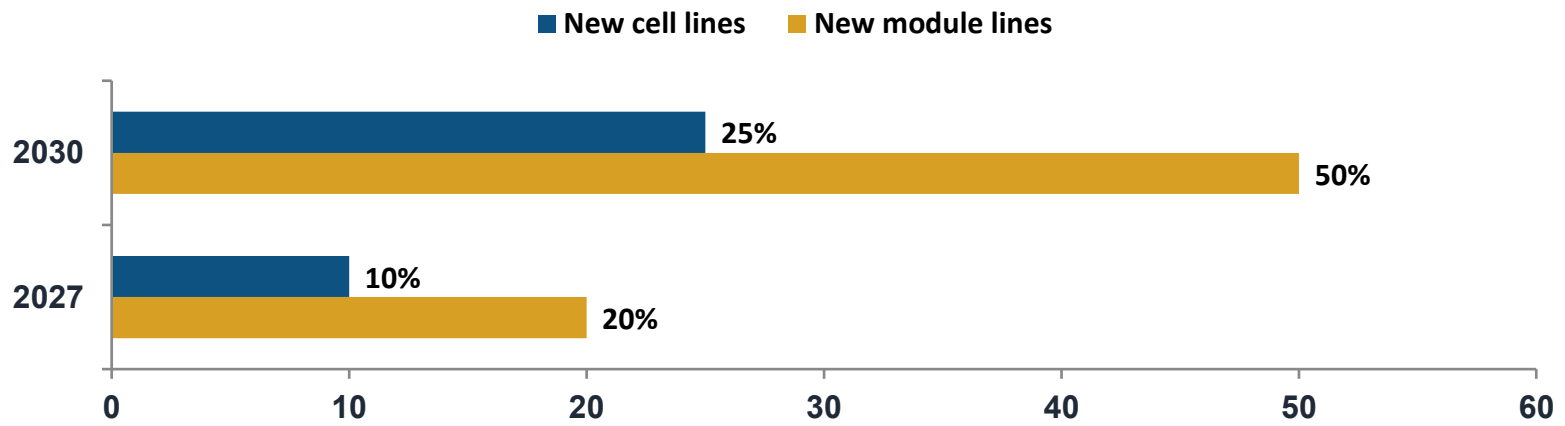
Exports

Pilot

first scalable export corridors

(Industry)

Local equipment content targets (illustrative, by value)



Indicative thresholds to signal early localisation of module and cell equipment not full self-sufficiency.

Recommendations

A pragmatic “execution stack” for 2030

1) De-risk manufacturing utilisation

- Provide predictable demand (tender pacing + rooftop scale-up)
- Align ALMM cadence with project pipelines
- Enable export readiness via quality + ESG alignment

2) Finance as a competitiveness lever

- Lower cost of capital for manufacturing (tenor + guarantees)
- Working-capital instruments for inventory and receivables
- Link incentives to performance (yield, energy, quality)

3) Build the missing “middle”

- Scale **wafers and polysilicon** with energy + water planning
- Close BOM gaps (glass, frames, backsheets, silver paste)
- Accelerate domestic equipment capability (test-beds + standards)

4) Invest in innovation clusters

- Perovskite/HJT process capability + reliability testing
- Recycling & circularity pilots (EoL modules)
- Skilling pipeline for automation + metrology

Solar manufacturing clusters | Shared pilot lines | Reliability & testing labs | Industry–research consortia

Ecosystem Enablers

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Thank you!

Always Open for Questions and Collaboration ☺

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Report

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